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California Environmental Protection Agency



Spark-Ignition Marine Vessel Evaporative Emissions Test Procedure

TP - 1501

**Test Procedure for Determining Diurnal Evaporative
Emissions from Spark-Ignition Marine Vessels**

Adopted Date: XXX

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Air Resources Board**

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A set of definitions common to all Certification and Test Procedures is in Title 13, California Code of Regulations (CCR), Section 2752 et seq. These definitions apply to all applicable instances in this test procedure.

For the purpose of this procedure, the term "ARB" refers to the California Air Resources Board, and the term "Executive Officer" refers to the ARB Executive Officer or his or her authorized representative or designate.

1. APPLICABILITY

This Test Procedure, TP-1501, is used to determine the diurnal evaporative emissions from spark-ignition marine vessels. This Test Procedure is proposed pursuant to sections 43013, 43018, 39600, and 39601 of the California Health and Safety Code (CH&SC), and is applicable in all cases where spark-ignition marine vessels are sold, supplied, offered for sale, or manufactured for use in the State of California.

1.1 Requirement to Comply with All Other Applicable Codes and Regulations

Certification or approval of any evaporative emission control system by the Executive Officer does not exempt the engine or evaporative emission control systems from compliance with other applicable codes and regulations such as state and federal safety codes and regulations.

1.2 Safety

This test procedure involves the use of flammable materials and possibly hazardous operations and should only be conducted by or under the supervision of those familiar and experienced in the safe use of such materials and operations. Appropriate safety precautions should be observed at all times while performing the test sequences in this test procedure.

2. PERFORMANCE STANDARDS

The minimum performance standard for certification of evaporative emission control systems on spark-ignition marine vessels is contained in CCR Title 13, Chapter 15, Article 4, section 2855.

3. PRE-CERTIFICATION REQUIREMENTS

3.1 Durability

A demonstration of durability of the applicant's evaporative emission control system is required prior to performing an evaporative emissions test.

Prior to the commencement of a durability demonstration, the applicant is required to submit and obtain approval of an evaporative emission durability test procedure. The test procedure must subject all evaporative emission control system components to conditions representative of those likely to be experienced throughout their useful life. Once the emission durability test procedure is approved, the approval remains valid for certifying all subsequent model years provided that no major changes are made to the evaporative emission family control system. If major changes are made to the evaporative control system, the previously approved durability test procedures no longer applies and approval of a revised durability test procedures is required.

4. GENERAL SUMMARY OF TEST PROCEDURE

A Sealed Housing for Evaporative Determination (SHED) is used to measure diurnal emissions. This method subjects spark-ignition marine vessels to a temperature profile while maintaining a constant pressure and continuously sampling for hydrocarbons with a Flame Ionization Detector (FID). The mass of total hydrocarbons from an evaporative control system over the test period is calculated using the ideal gas equation in 40 CFR section 86.117-96(d)(1).

This test procedure measures diurnal emissions from spark-ignition marine vessels with complete evaporative emission control systems as defined in 13 CCR 2752 (a)(8). The basic process is as follows:

- Fill the spark-ignition marine vessel's fuel tank to 55% with fuel
- Operate engine at 50% maximum governed speed for 15 minutes
- Precondition the evaporative emission control and fuel delivery system
- Drain and fill fuel tank to 55% capacity with E10 CERT fuel
- Purge carbon canister (if so equipped)
- Operate engine at 50% maximum governed speed for fifteen minutes to allow the engine to reach normal operating temperature
- Subject the vessel to a three-hour constant 105°F hot soak procedure
- Soak the vessel until fuel temperature reaches 65°F
- Subject the vessel to a 24-hour (65°F - 105°F - 65°F) diurnal temperature profile

The corrected diurnal mass of total hydrocarbons measured by the SHED over the 24-hour diurnal temperature profile is compared with the performance standard in CCR Title 13, Chapter 15, Article 4, section 2855. Evaporative control systems that achieve results less than or equal to the performance standard are considered compliant.

5. INSTRUMENTATION

The instrumentation necessary to perform evaporative emission testing for spark-ignition marine vessels is the same instrumentation used for passenger cars and light duty vehicles, and is described in 40 CFR 86.107-96.

5.1 Calibrations

Evaporative emission enclosure calibrations are specified in 40 CFR section 86.117-90, as incorporated by reference amended with the following subsection:

§1.1 The diurnal evaporative emission measurement enclosure calibration consists of the following parts: initial and periodic determination of enclosure background emissions, initial determination of enclosure volume, and periodic hydrocarbon (HC) and ethanol retention check and calibration. Calibration for HC and ethanol may be conducted in the same test run or in sequential test runs.

- All test fuels must be tested to ensure they meet ARB specification for E10 CERT fuel.
- The SHED must be able to collect minute by minute emissions and temperature data.
- The SHED must be able to control temperature to within the specification of this test procedure while keeping pressure constant.

5.2 Calculation of Hydrocarbon Mass

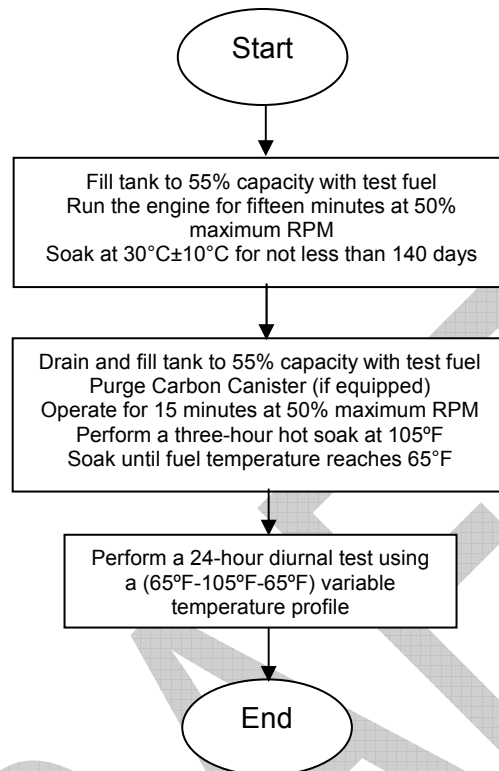
Calculate the final recovered hydrocarbon mass (M_{HC}) according to 40 CFR section 86.117-96(d)(1).

6. TEST PROCEDURE

The test sequence is shown graphically in Figure 1. All monitored temperatures are tank fuel temperatures. The equipment shall be approximately level during all phases of the test sequence to prevent abnormal fuel distribution. The temperature tolerance of a soak period may be waived for up to 10 minutes to allow purging of the enclosure or transporting the equipment into the enclosure.

Testing a representative piece of equipment for each evaporative family and comparing the results to the appropriate performance standard determines compliance with requirements of CCR Title 13, Chapter 15, Article 4, section 2855. The 24-hour diurnal test sequence is shown in Figure 6.1.

Figure 6.1



6.1 Fuel Tank / Fuel System Preconditioning

The purpose of the preconditioning period is to introduce gasoline into the fuel system and precondition all fuel system components. Precondition the tank and other fuel delivery system components by filling the tank to 55% of its nominal capacity with fresh E10 CERT fuel as specified in Section 7 of these procedures. After filling the tank start the engine and allow it to run at 50% of the maximum rated speed for approximately fifteen minutes. Soak the tank and other components at 30°C \pm 10°C for not less than 140 days. Data documenting that the tank has reached equilibrium must be provided for tanks soaked less than 140 days. The period of slosh testing may be considered part of the preconditioning period provided each tank and all fuel system components tested remain filled with fuel and are never empty for more than one hour over the entire preconditioning period.

6.2 Refueling and Hot Soak Procedure

Following the preconditioning period, drain the fuel tank and refill to 55 percent of its nominal capacity with E10 CERT fuel. For evaporative emission control systems that use a carbon canister, the canister must be purged following the preconditioning period but prior to initiating the hot soak procedure. The sequence starts by first bench purging the canister with 400 bed volumes of dry air or nitrogen in 30 minutes. Bed volume is the design volume of the carbon contained in the canister. The purge rate will therefore vary with canister size. Purge may be accomplished by drawing a vacuum at the tank or purge port, or by pushing air or N2 into the atmospheric vent. Operate the engine at 50%

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of its maximum governed speed for fifteen minutes. Immediately place the engine in the SHED enclosure preheated to 105°F within two minutes. Perform a three-hour hot soak at a constant 105°F.

6.3 Forced Cooling

After the hot soak procedure, purge the enclosure to reduce the hydrocarbon concentration to near background levels. Cool the enclosure to attain a wall temperature of 65°F ± 3.0°F. After cooling the enclosure to 65°F, soak the vessel in the enclosure until the fuel temperature reaches 65°F ± 3.0°F.

6.4 24-Hour Diurnal Test

Immediately after soaking, purge the enclosure to reduce the hydrocarbon concentration to near background levels and perform a 24-hour diurnal test using the temperature profile shown in Table 6.1.

Table 6.1
Diurnal Temperature Profile

Hour	0	1	2	3	4	5	6	7	8	9	10	11	12
(°F)	65.0	66.6	72.6	80.3	86.1	90.6	94.6	98.1	101.2	103.4	104.9	105.0	104.2
Hour	13	14	15	16	17	18	19	20	21	22	23	24	--
(°F)	101.1	95.3	88.8	84.4	80.8	77.8	75.3	72.0	70.0	68.2	66.5	65.0	--

6.5 Calculation of Mass of Diurnal Evaporative Emissions

The calculation of the mass of the diurnal evaporative emissions is specified in Part III of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles." as incorporated by reference in Title 13, California Code of Regulations, Section 1976(c).

7. TEST FUEL

E10 CERT Fuel: defined as the interim E10 CERT fuel until the adoption date of a California E10 certification fuel. The interim E10 certification fuel can continue to be used until one year after the adoption of a Californian E10 certification fuel.

Table 7.1 – E10 CERT Fuel Specifications

Fuel Property	Upper Limit
RVP	6.95 psi
T50	214 °F
T90	312 °F
Total Aromatic Hydrocarbons	24 vol. %
Olefins	7.4 vol. %
Total Oxygen	3.5

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Sulfur	8 ppm by wt.
Benzene	0.74 vol. %
Ethanol	10 vol. %

8. ALTERNATIVE TEST PROCEDURES

Test procedures, other than specified above, shall only be used if prior written approval is obtained from the Executive Officer. In order to secure the ARB Executive Officer's approval of an alternative test procedure, the applicant is responsible for demonstrating to the ARB Executive Officer's satisfaction that the alternative test procedure is equivalent to this test procedure.

(1) Documentation of any such approvals and demonstrations shall be maintained by the ARB Executive Officer and shall be made available upon request.

(2) Once approved for use, an alternative test procedure may be used and referenced by any manufacturer subject to the limitations and constraints in the Executive Order approving the alternative test procedure.

9. REFERENCES

1. California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, California Environmental Protection Agency, Air Resources Board, El Monte, CA, 2000.
2. California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, California Environmental Protection Agency, Air Resources Board, El Monte, CA, 2002.
3. 40 CFR Part 86